



MARINE CONTROL SYSTEM

INSTALLATION AND SERVICE MANUAL FOR LOGICMASTER® CONTROL UNIT Part Number R431007528 (P -090008-00000)



WARNING: INSTALLATION AND MOUNTING

The user of these devices must conform to all applicable electrical, mechanical, piping and other codes in the installation, operation or repair of these devices.

INSTALLATION! Do not attempt to install, operate or repair these devices without proper training in the technique of working on pneumatic or hydraulic systems and devices, unless under trained supervision.

Compressed air and hydraulic systems contain high levels of stored energy. Do not attempt to connect, disconnect or repair these products when a system is under pressure. Always exhaust or drain the pressure from a system before performing any service work. Failure to do so can result in serious personal injury.

MOUNTING! Devices should be mounted and positioned in such a manner that they cannot be accidentally operated.

TABLE OF CONTENTS

TITLE	PAGE
A - GENERAL DESCRIPTION	2
B - DESCRIPTION OF OPERATION	2
C - ADJUSTMENTS & SETTINGS	4
D - COMPONENT LOCATION & MATERIAL LIST	7
E - SCHEMATIC DIAGRAM	8
F - INSTALLATION DATA	9
G -SERVICE PARTS INFORMATION	10-15
Shuttle Valve	
Flow Control Valve	
Multi-function Logic Valve	
Multi-function Logic Valve - Hydraulic Control Signal	
Pressure Regulator	
Logic Timer Unit	

General Description

The Logicmaster® Control Unit is designed for service with hydraulic clutch type reverse gears, such as those manufactured by -

Allison Div. - General Motors Corp.
Caterpillar Tractor
Twin Disc, Inc.

The Logicmaster combines proven dependable control components into a factory assembled and tested unit ready for shipboard installation. All factory adjustments are accomplished, as outlined on page 4.

Shipboard piping connections are made to the tapped manifold connections, as specified on installation diagram, page 7. Care must be exercised in the shipboard installation and piping to insure a satisfactory control installation.

The Logicmaster Unit should be located in close proximity to the reverse gear to minimize the length of tubing runs to the reverse gear selector cylinder, the hydraulic pressure interlock connection, safety drain connection to the gear sump, and the engine governor Actuator.

All tubing runs should be securely fastened and insulated where necessary, for maximum protection against vibration damage and metal-to-metal surface chafing. Tubing runs should be located such that they will be protected and not in exposed locations susceptible to undesired usage, such as foot steps or hand holds, which may lead to breakage or ultimate flattening of the tubing with consequent flow restrictions. Flexible connections should be provided between all engine and reverse gear mounted devices and connections. All tubing bends should be accomplished with smooth radius bends to avoid pinching and flow restriction.

Important - All tubing lines should be blown through with clean, dry air prior to making the final connection at each end to insure that all cuttings, chips, dirt, and foreign material is removed. If brazed or soldered connections or couplings are used, extreme care should be exercised to insure that flux is not introduced into the control lines. All piping connections should be pressure tested to insure zero leakage.

For optimum service, a constant 100 psi (6.9 bar) air supply should be maintained for the control system. Adequate precautions should be taken in the shipboard air system to insure a reasonably clean, dry air supply for the control system and

Logicmaster Unit operation.

Factory recommended control systems provide for filtering of the supply air to remove foreign material. Adequate shipboard procedures must be exercised to insure that the main ship's air supply system is properly drained and maintained to prevent excessive condensation and moisture carry-over into the control system supply.

Description of Operation

This control system provides interlocked and sequenced operation of the reverse gear engagement, the shaft brake application and release in coordination with the reverse gear, and engine speed control to insure proper operation of the propulsion machinery no matter how the operator manipulates the remotely mounted control lever. The control system incorporates the following interlocks and operational features.

1. Times Reversing Interlock

Holds the clutch control in neutral position for a preset time on reversals even though the remote control lever is shifted directly through neutral. This allows engine speed to decrease to idle and the shaft brake to apply and stop the propeller before reversing. Timing is adjustable.

2. Clutch Pressure - Throttle Control Interlock

Monitors the buildup of hydraulic pressure in the clutch during engagement. Clutch pressure must reach preset engagement level before engine speed can be advanced from the remote control station to prevent high engine speed during clutch engagement with resultant clutch wear. This feature also protects the reverse gear if clutch pressure drops during operation. Loss of clutch pressure releases the interlock and engine speed is reduced to idle preventing clutch damage.

3. Power Boost

Advances governor setting during clutch engagement to provide increased engine torque and prevent stalling as the propeller load is applied. On completion of clutch engagement, the boost drops off and the governor is positioned to the setting called for by the pilothouse control lever. Governor power boost can be adjust for desired magnitude and duration.

4. Clutch Pressure - Shaft Brake Interlock

Monitors the buildup of hydraulic pressure in the clutch to release the shaft brake upon initial engagement of the clutch. When clutch is disengaged, the drop in clutch pressure allows the shaft brake to be applied. This insures that the shaft brake cannot be applied when either clutch is engaged.

The control system will operate in the following manner. Detailed operational description of each control component is explained in the individual component publication.

For ahead operation, a signal is delivered from the remote control station into Logicmaster® connection 1C to the normally open reversing interlock valve (10). This pressure passes through (10) and out of connection 1A to actuate the spring centered reverse gear control cylinder into ahead position. The ahead signal also passes -

1. Through shuttle valve (1) to the power boost valve (3). This actuates the valve to deliver a preset pressure from regulator (4) to (11) and thence to the engine governor actuator to increase the governor setting to prevent stalling as the clutch engages. Pressure from (1) also flows through Timer Unit (2) under the diaphragm of (3). After a time period, as set by (2) this pressure equalizes with that applied to the opposite side of the diaphragm, and (3) is spring returned to its original condition. The boost pressure is released from the engine governor. The governor boost is adjustable in magnitude by regulator (4) and in duration by Timer Unit (2).
2. Through shuttle valve (1) to actuate throttle intercept valve (8) to connect the remote speed line through to the hydraulic interlock valve (11). When clutch oil pressure reaches 110 psi (7.6 bar), the hydraulic interlock valve (11) is operated connecting the governor actuator to the remote speed control line. The engine speed can now be increased, as desired from the remote control station. This insures that the clutch is fully engaged before the speed is allowed to increase and prevents high engine speed during engagement with resultant high slippage and clutch wear. Interlock valve (11) also provides protection in the event gear pressure drops during normal running. Should this occur, it will release (11) and reduce engine speed to idle, thus alerting the operator to the problem and prevent damaging the clutches from excessive slippage at high engine speeds.

3. Ahead signal passes through Timer Unit (5) to the control connection of interlock valve (9) installed in the astern line 3C. Valve (9) is actuated to intercept the astern line and prevent any astern actuation of the reverse gear control cylinder until the ahead signal is fully vented. Thus on reversals, a neutral time interlock is provided during which the engine speed is held at idle and the shaft brake is applied. The neutral time period must be long enough to allow the brake to stop the propeller before astern actuation of the reverse gear control cylinder is permitted. The neutral time is adjustable by means of Timer Units (5) for ahead to astern and (6) for astern to ahead.

The shaft brake is controlled by hydraulic interlock valve (12) so that whenever clutch engagement is initiated, valve (12) is actuated by the initial buildup of oil pressure in the clutch to release the shaft brake. When the clutch is disengaged, valve (12) is released and allows the shaft brake to be applied. This insures that the brake will not be applied whenever the clutch is engaged.

Astern operation is the same as described above for ahead, except that control lines 3C and 3A are pressurized and the reversal timing interlock is provided by valve (10) and Timer Units (6).

The control system will function on direct reversals as follows:

Operating Sequence

- Operator moves control **full ahead** to **full astern**
- Governor to **idle**
- Reverse gear to **neutral**
- Shaft Brake Applied
- Neutral Time Interlock holds Reverse Gear in Neutral
- Propeller shaft stops
- Reverse Gear shifts **astern**
- Shaft brake released
- Governor power boost applied
- Clutch pressure reaches lock-up
- Governor power boost terminates, governor advances to **full speed**

Adjustments & Settings

The following adjustments and settings are made during the factory test of the Logicmaster® unit but may require additional tuning on shipboard to provide the optimum system operation. All factory adjustments are accomplished with a control system operating pressure of 100 psi (6.9 bar).

1. Power Boost Regulator Setting

The power boost regulator (4) is factory set at 20 psi (1.4 bar). This may be adjusted to suit the final installation requirements. Turning in on the regulator adjusting cap will increase the power boost. Backing out on the adjusting cap will lower the boost. The objective is to provide sufficient boost to prevent engine stalling during reversal maneuvers. Caution should be exercised to avoid excessive power boost. Final adjustments should be made during underway trials of the vessel.

2. Duration of Power Boost Application

The power boost is applied to the engine by the actuation of valve (3) when a direction signal is applied to the reverse gear cylinder. The length of time the boost signal is applied through valve (3) is controlled by Timer Unit (2). This is factory set for approximately 5 seconds. To shorten this time, the adjusting screw of Timer Unit (2) should be turned out.

The effect of (2) setting can be observed by the response of the governor actuator. In operation the power boost will be terminated by the actuation of hydraulic interlock valve (11). The setting of (2) should be sufficient to hold the power boost until engagement is completed.

This adjustment can be made without the engine running by operating the remote control lever and observing the operation of

the governor actuator. A gage can be installed in the actuator line if necessary.

If the engine is running, the adjustment can be made by disconnecting the reverse gear actuating cylinder from the selector lever and operating the control system. The power boost actuation can be observed by the engine speed increase response and can be timed by observing when the engine speed returns to idle.

3. Reversal Interlock Timing

Timer Units (5) and (6), in conjunction with interlock valves (9) and (10), provide a reversal time interlock to insure that the reverse gear is held in neutral for a preset time on reversals even though the remote control lever is shifted directly through neutral. This allows the engine speed to return to idle and provides time for the shaft brake to be applied and stop the propeller shaft before reversal is initiated. This timing is factory set for 4 seconds.

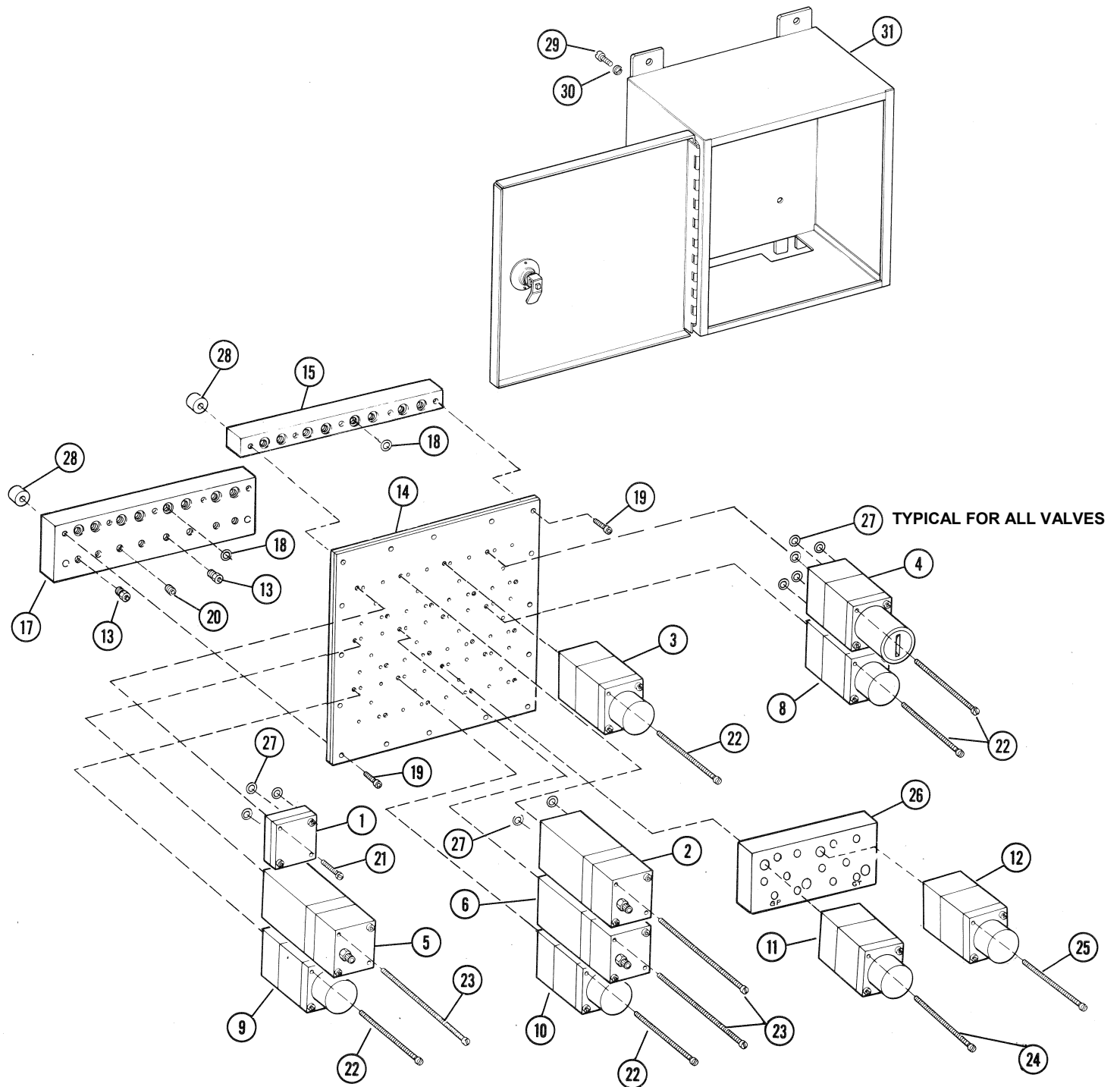
To shorten the timing, back out on the adjusting screw of Timer Unit (5) or (6) as required. To lengthen the timing, turn in on the adjusting screw. Lock the adjusting screw after changing settings.

Timer Unit (5) controls the timing from ahead to astern. Timer Unit (6) controls the timing from astern to ahead.

Final adjustments should be made during underway trials of the vessel.

LM-2 **LOGICMASTER[®]** CONTROL UNIT

PART NO. R431007528 (P -090008-00000)



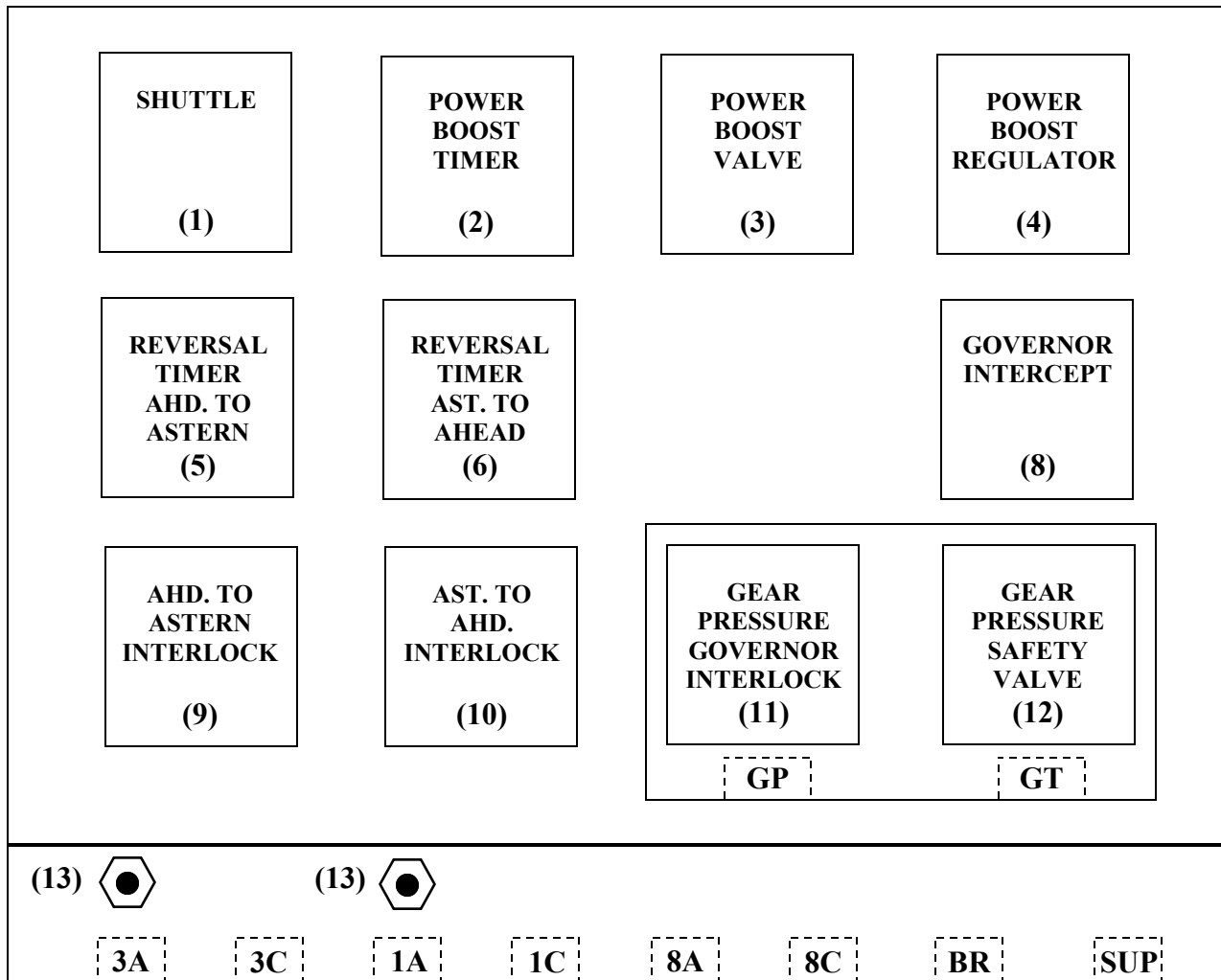
PARTS LIST

LM-2 LOGICMASTER® UNIT

P -090008-00000

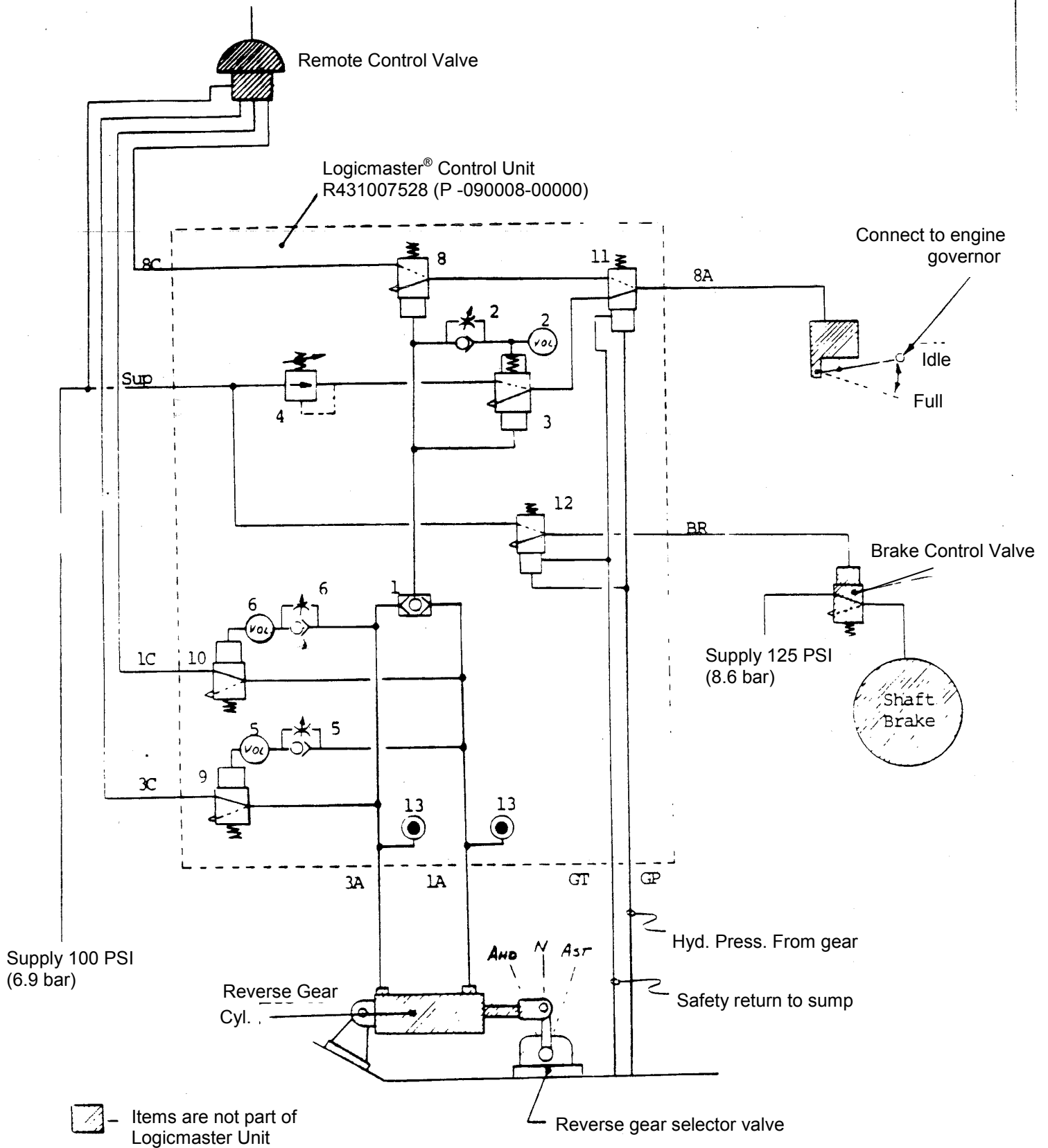
REF.	QTY.	DESCRIPTION	NEW PART NO.	OLD PART NO.
1	1	Shuttle Valve (See Bulletin B6-104.05)	R431005928	P -061971-00000
2	1	Timer Unit (See Bulletin B6-105.04)-consisting of	R431006335	P -064003-00000
		(A) - Flow Control Valve (See Bulletin B6-105.03)	R431005931	P -061975-00002
		(B) - Timing Volume (Time In)	R431006229	P -063395-00005
3		Logic Valve - 15 psi (See Bulletin B4-70.01)	R431005976	P -062016-00000
4	1	Pressure Regulator (See Bulletin B6-107.05)	R431005985	P -062018-00000
5 & 6	2	Timer Unit (See Bulletin B6-105.04) - consisting of	R431006336	P -064003-00001
		(A) - Flow Control Valve (See Bulletin B6-105.03)	R431005931	P -061975-00002
		(B) - Timing Volume (Time Out)	R431006230	P -063395-00006
8	1	Logic Valve - 80 psi (See Bulletin B4-70.01)	R431005980	P -062016-00004
9 & 10	2	Logic Valve - 15 psi (See Bulletin B4-70.01)	R431005976	P -062016-00000
11	1	Hydraulic Logic Valve (See Bulletin B4-70.04) - 110 psi	R431005967	P -062014-00000
12	1	Hydraulic Logic Valve (See Bulletin B4-70.04) - 35 psi	R431005968	P -062014-00001
13	2	Pressure Indicator	R431006263	P -063431-00000
14	1	Circuit Plate Assembly	R431007535	P -090072-00001
15	1	Upper Header Bar	R431006045	P -062370-00000
17	1	Lower Header Bar	R431006262	P -063430-00000
18	16	"O" Ring Seal	R432012138	P -049708-00012
19	10	Allen Screw, #8 x 1"	R431002312	P -049856-00124
20	6	Pipe Plug	R431002133	P -049787-00000
21	2	Mounting Screw, #8 x 1 ½"	R431001772	P -049467-00013
22	10	Mounting Screw, #8 x 3½"	R431001771	P -049467-00012
23	6	Mounting Screw, #8 x 5½"	R431001775	P -049467-00016
24	4	Mounting Screw, #8 x 4¾"	R431001776	P -049467-00017
26	1	Subplate, Hydraulic Valve Mounting	R431006308	P 063880-00001
27	54	"O" Ring Seal	R431002010	P -049708-00106
28	4	Spacers	R431006270	P -063458-00000
29	4	Mounting Screw	R431002247	P -049835-00014
30	4	Lockwasher	R431002572	P -049982-00006
31	1	Enclosure	R431006271	P -063459-00000

COMPONENT LOCATION & MATERIAL LIST

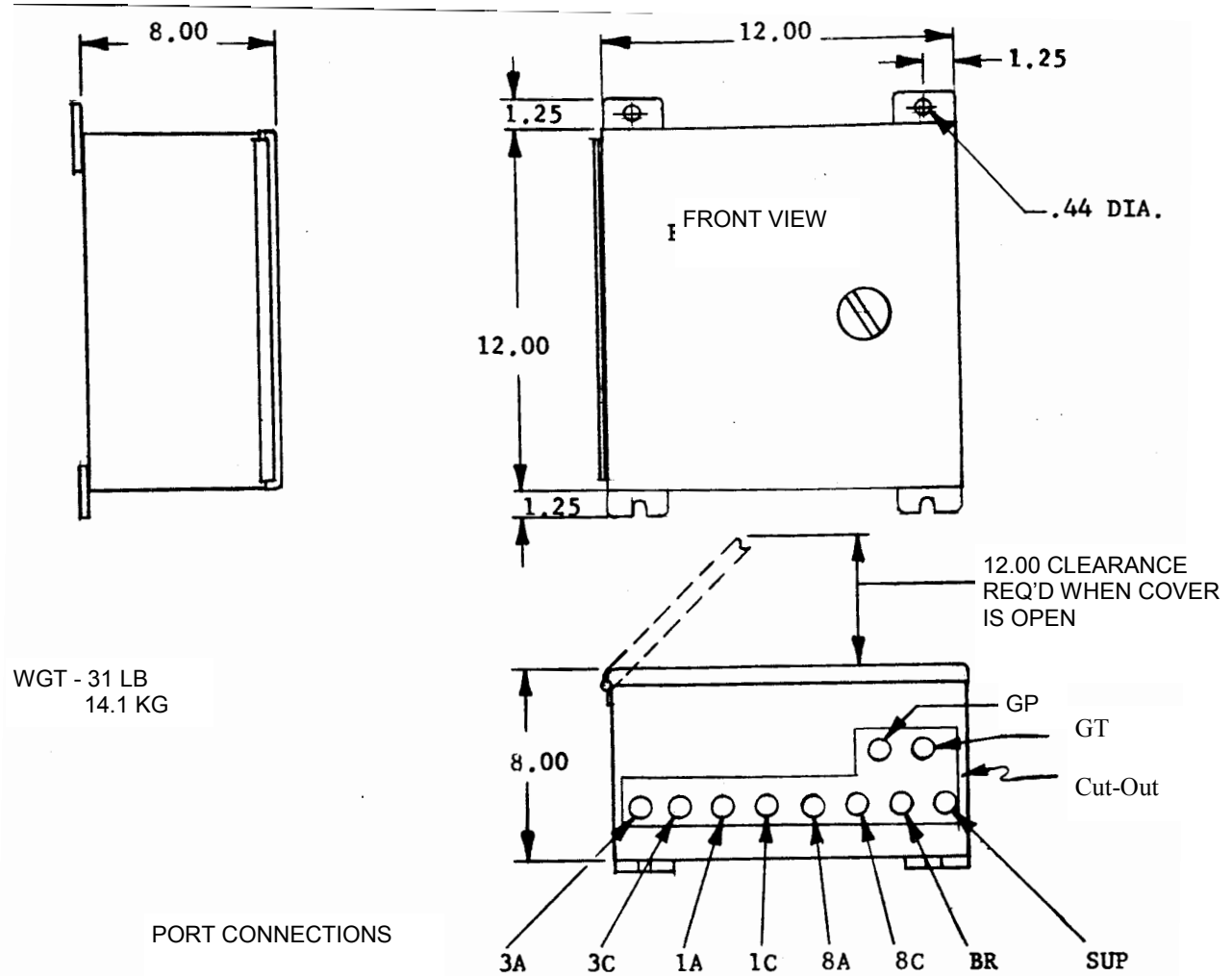


REF.	NEW PART NO.	OLD PART NO.	DESCRIPTION
1	R431005928	P -061971-00000	Shuttle Valve
2	R431006335	P -064003-00000	Timer Unit - Consisting of Flow Control Valve Part No. R431005931 (P -061975-00002) and volume (time in) Part No. R431006229 (P -063395-00005)
3	R431005976	P -062016-00000	Multifunction Logic Valve - 15 psi
4	R431005985	P -062018-00000	Pressure Regulator
5, 6	R431006336	P -064003-00001	Timer Unit - consisting of Flow Control Valve Part No. R431005931 (P -061975-00002) and Volume (time out) Part No. R431006230 (P -063395-00006)
8	R431005980	P -062016-00004	Multi-Function Logic Valve - 80 psi
9, 10	R431005976	P -062016-00000	Multi-Function Logic Valve - 15 psi
11	R431005967	P -062014-00000	Hydraulic Multi-Function Logic Valve - 110 psi
12	R431005968	P -062014-00001	Hydraulic Multi-Function Logic Valve - 35 psi
13	R431006263	P -063431-00000	Pressure Indicator

SCHEMATIC DIAGRAM LOGICMASTER® CONTROL UNIT *-TM2*



INSTALLATION DETAILS

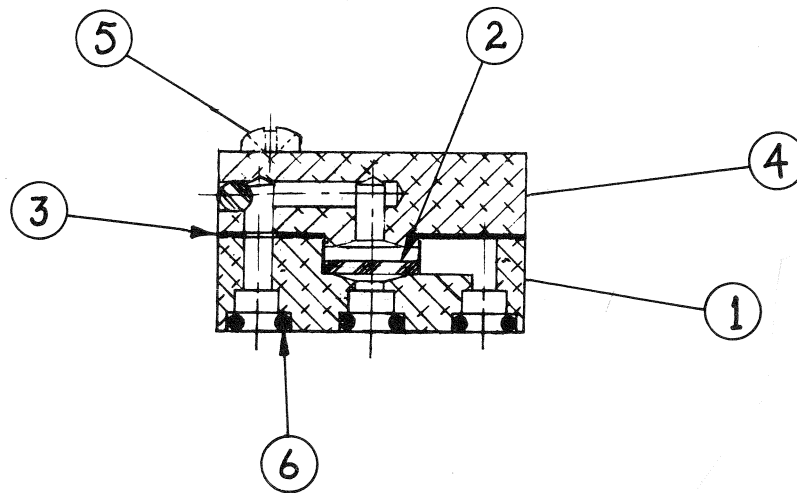


NOTE: ALL CONNECTIONS ARE 1/8"-27 NPT FEMALE PIPE PORTS

PORT IDENTIFICATIONS

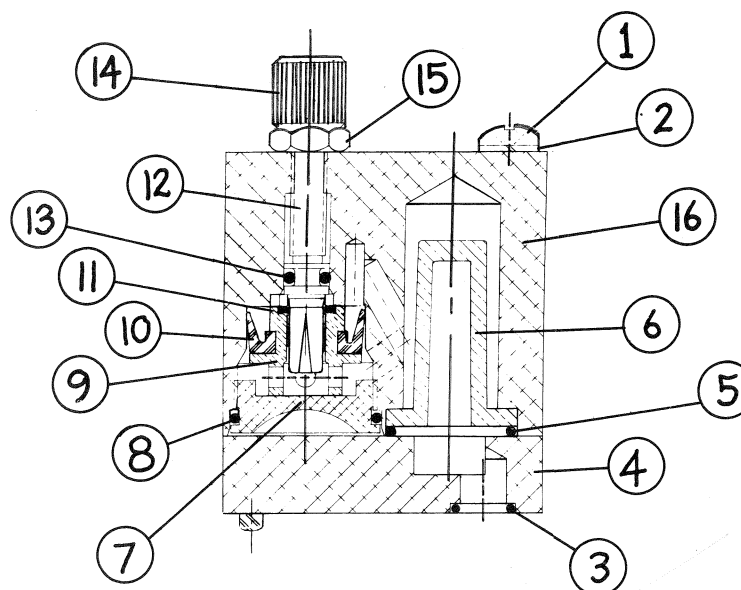
PORT NO.	FUNCTION
3A	Astern Actuation - Outlet
3C	Astern Control - Inlet
1A	Ahead Actuation - Outlet
1C	Ahead Control - Inlet
8A	Speed Actuation - Outlet
8C	Speed Control - Inlet
BR	Brake - Shaft Brake Control -Plugged for R431007529 (P-090008-00001)
SUP	Supply - 100 PSI - Inlet (6.9 bar)
GP	Gear Pressure - Hydraulic Clutch Pressure
GT	Gear Tank - Safety Return to Gear SUMP

LOGIC SHUTTLE VALVE



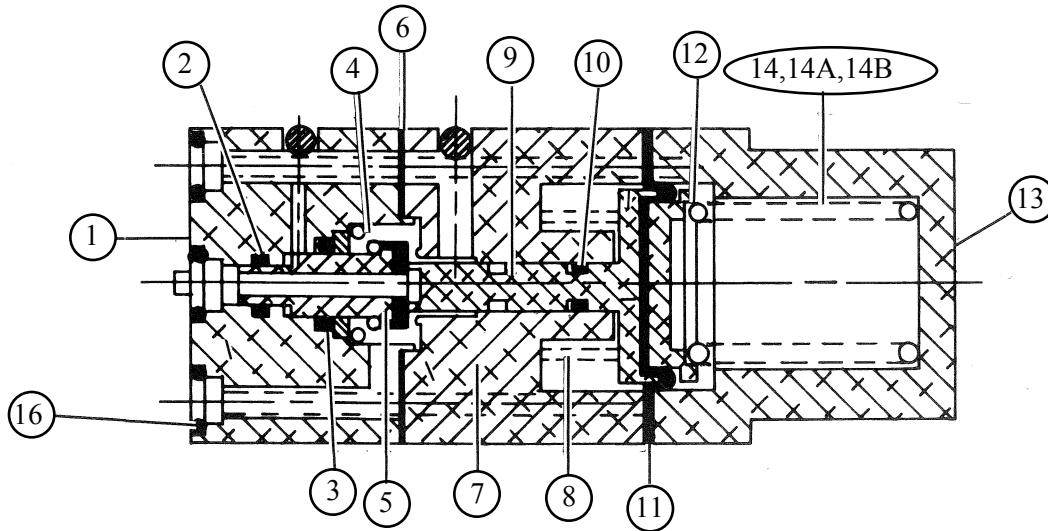
REF.	QTY.	DESCRIPTION	NEW PART NO.	OLD PART NO.
LOGIC SHUTTLE VALVE, Complete			R431005928	P -061971-00000
1	1	BODY	R431005938	P -061979-00001
2*	1	DIAPHRAGM	See Kit	See Kit
3*	1	GASKET	See Kit	See Kit
4	1	COVER	R431005940	P -061980-00001
5	2	SCREW, 8-32 X 3/4	R431001690	P -049109-00000
6*	3	"O" RING, 3/8 O.D.	See Kit	See Kit
* Recommended spare parts to be retained in stock				
* Available in Repair Kit form, Part No. R431006240 (P -063400-00000)				

LOGIC FLOW CONTROL VALVE



REF.	QTY.	DESCRIPTION	NEW PART NO.	OLD PART NO.
LOGIC FLOW CONTROL VALVE, Complete			R431005931	P -061975-00002
1	2	SCREW, 8/32" x 1-3/4"	R431001692	P -049109-00002
2	2	LOCKWASHER	R432012235	P -049866-00003
3*	2	"O" RING, 3/8" O.D.	See Kit	See Kit
4	1	BASE	R431005956	P -062000-00001
5*	2	"O" RING, 9/16" O.D.	See Kit	See Kit
6	2	FILTER	R431005954	P -061999-00000
7	1	CAP	R431005953	P -061998-00000
8*	1	"O" RING, 3/4 O.D.	See Kit	See Kit
9	1	GUIDE	R431005952	P -061997-00000
10*	1	"U" CUP	See Kit	See Kit
11*	1	"O" RING, 5/16" O.D.	See Kit	See Kit
12	1	SCREW, Regulating	R431005951	P -061996-00000
13*	1	"O" RING, 1/4" O.D.	See Kit	See Kit
14	1	NUT, Knurled	R431006292	P -063497-00000
15	1	JAM NUT, 10-48 Hex	R431002426	P -049901-00036
16	1	HOUSING	R431005950	P -061995-00000
* Recommended spare parts to be retained in stock				
* Available in Repair Kit form, Part No. R431006224(P -063393-00000)				

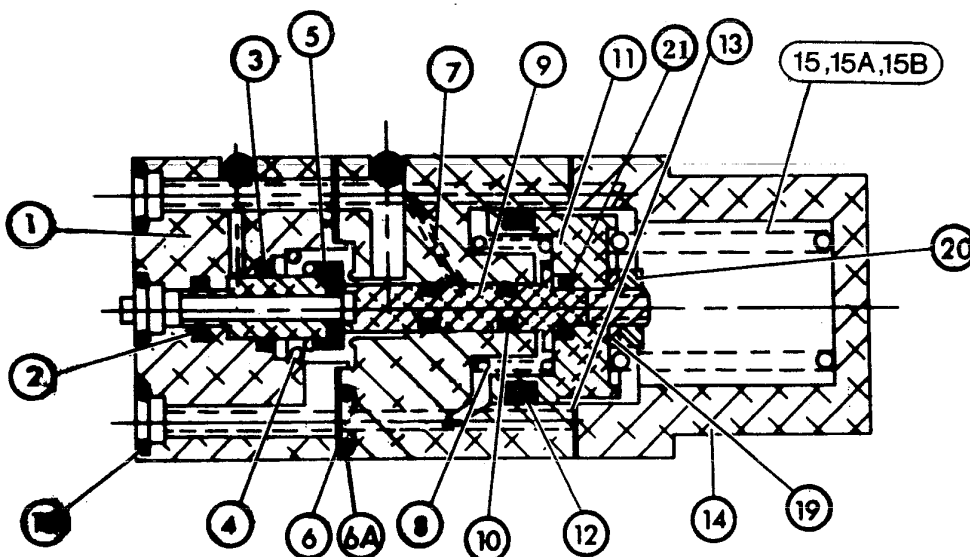
MULTIFUNCTION LOGIC VALVE
PART NO. R431005976 (P -062016-00000)



REF.	QTY.	DESCRIPTION	NEW PART NO.	OLD PART NO.
MULTIFUNCTION LOGIC VALVE (15 psi) Complete			R431005976	P -062016-00000
MULTIFUNCTION LOGIC VALVE (30 psi) Complete			R431005977	P -062016-00001
MULTIFUNCTION LOGIC VALVE (80 psi) Complete			R431005980	P -062016-00004
1	1	BODY	R431007038	P -067247-00000
2*	1	O-RING, 7/32" x 11/32"	See Kit	See Kit
3*	1	O-RING, 3/8" x 1/2"	See Kit	See Kit
4	1	SPRING, Supply Valve	R431006176	P -063075-00000
5*	1	VALVE, Supply	See Kit	See Kit
6*	1	Gasket, Body	See Kit	See Kit
7	1	BODY, Valve Seat	R431007041	P -067249-00000
8	1	SEAT, Exhaust Valve	R431003030	P -052889-00000
9	1	SPRING, Exhaust Valve	R431005945	P -061986-00001
10*	1	O-RING, 1/8" x 1/4"	See Kit	See Kit
11*	1	DIAPHRAGM	See Kit	See Kit
12	1	SEAT, Spring	R431005946	P -061987-00000
13	1	COVER	R431007028	P -067156-00000
14	1	SPRING, Regulating 15 psi (1.1 bar)	R431005964	P -062012-00000
14A	1	SPRING, Regulating 30 psi (2.0 bar)	R431005965	P -062013-00000
14B	1	SPRING, Regulating 45 psi (3.1 bar)	R431005962	P -062011-00000
14C	1	SPRING, Regulating 80 psi (5.5 bar)	R431005489	P -060360-00000
14D	1	SPRING, Regulating 100 psi (6.9 bar)	R431006056	P -062448-00000
15	2	SCREW, 8-32 x 2-1/4" (Not shown)	R431001693	P -049109-00003
16	5	O-RING, 3/8" O.D.	R431002010	P -049708-00106
* Recommended spare parts to be retained in stock				
* Available in Repair Kit form, Part No. R431006223(P -063392-00000)				

MULTIFUNCTION LOGIC VALVE HYDRAULIC CONTROL SIGNAL

PART NO. R431005967 (P -062014-00000) & R431005968 (P -062014-00001)



REF.	QTY.	DESCRIPTION	NEW PART NO.	OLD PART NO.
MULTIFUNCTION LOGIC VALVE (35 psi) Complete			R431005968	P -062014-00001
MULTIFUNCTION LOGIC VALVE (110 psi) Complete			R431005957	P -062014-00000
MULTIFUNCTION LOGIC VALVE (220 psi) Complete			R431005969	P -062014-00003
1	1	BODY	R431007038	P -067247-00000
2*	1	O-RING, 7/32" x 11/32"	Unknown	See Kit
3*	1	O-RING, 3/8" x 1/2"	Unknown	See Kit
4	1	SPRING, Supply Valve	R431006176	P -063075-00000
5*	1	VALVE, Supply	Unknown	See Kit
6*	1	Gasket, Body	Unknown	See Kit
7	1	BODY, Valve Seat	Unknown	P -064693-00000
8	1	SPRING, Exhaust Valve	R431005588	P -060836-00000
9	1	VALVE, Piston	R431006469	P -064692-00001
10*	2	O-RING, 1/8" x 1/4"	Unknown	See Kit
11	1	PISTON	R431005958	P -062005-00000
12*	1	U-CUP SEAL	Unknown	See Kit
13*	1	GASKET, Cover	Unknown	See Kit
14	1	COVER	R431007028	P -067156-00000
15	1	SPRING, Regulating 35 psi (2.4 bar)	R431005965	P -062013-00000
15A	1	SPRING, Regulating 110 psi (7.6 bar)	R431006056	P -062448-00000
15B	1	SPRING, Regulating 220 psi (15.2 bar)	R431006081	P -062549-00000
16†	3	SHIMS, (Not shown)	R431003217	P -053455-00003
17	2	SCREW, 8-32 x 2-1/4" (Not shown)	R431001693	P -049109-00003
18*	5	O-RING, 3/8" O.D.	Unknown	See Kit
19	1	WASHER, Lock No. 10	R431002344	P -049866-00007
20	1	NUT, 10-32	R432012246	P -049901-00016
21	1	O-RING, 3/16" x 5/16"	R432012137	P -049708-00008

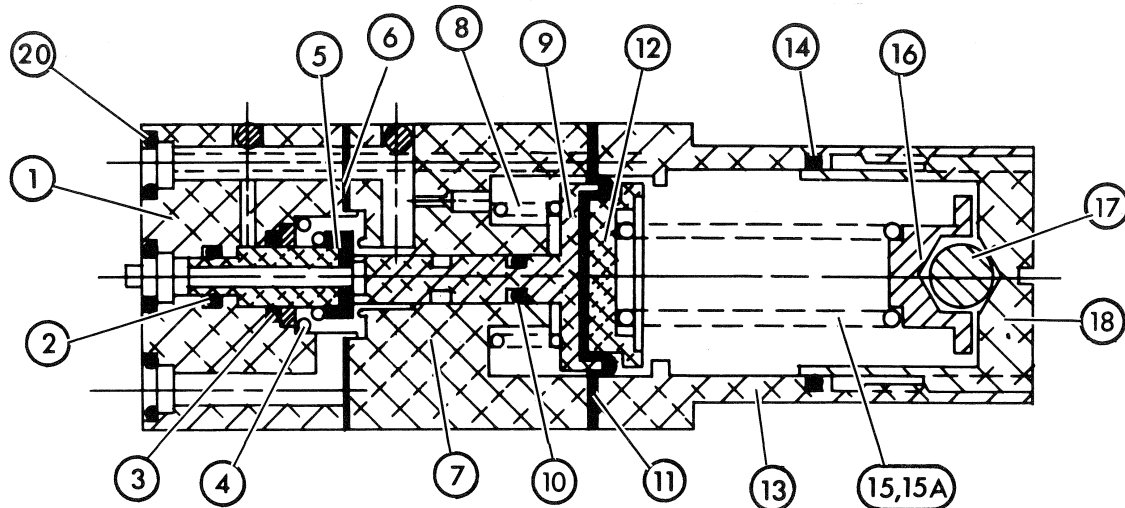
* Recommended spare parts to be retained in stock at all times.

* Available in Repair Kit form, Part No. R431006320(P -063967-00000)

† Maximum quantity required. Actual quantity installed at factory depends on spring ratings.

LOGIC PRESSURE REGULATOR

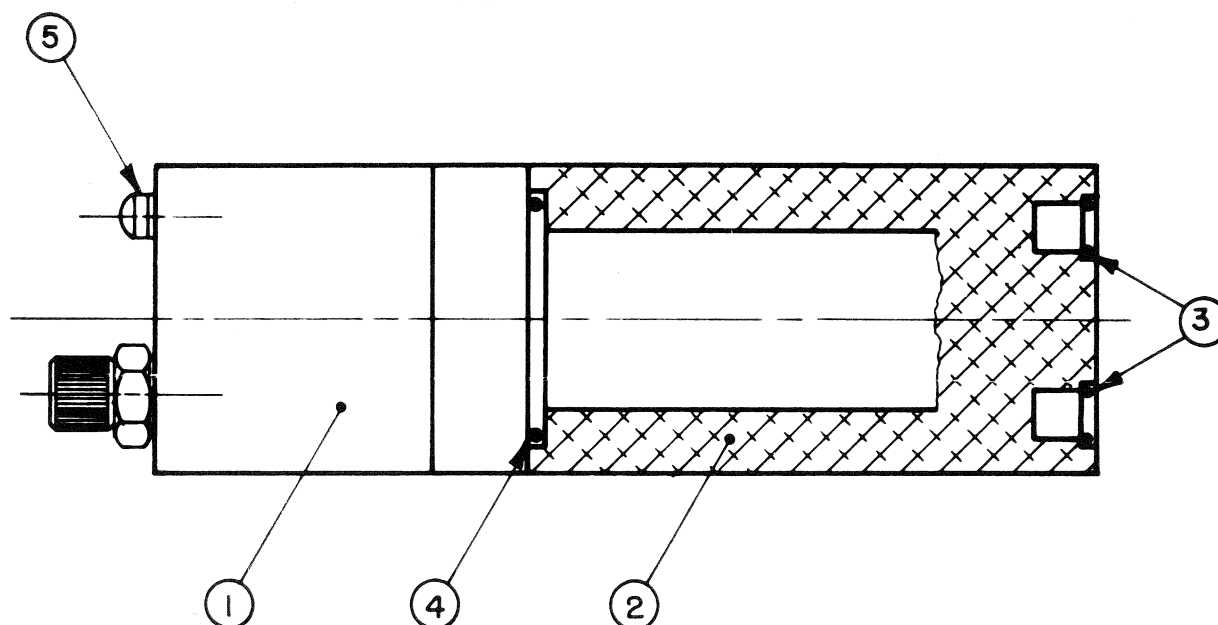
PART NO. R431005985 (P -62018-00000) & R431005986 (P -062018-000001)



REF.	QTY.	DESCRIPTION	NEW PART NO.	OLD PART NO.
LOGIC PRESSURE REGULATOR (75 psi) Complete			R431005985	P -062018-00000
LOGIC PRESSURE REGULATOR (140 psi) Complete			R431005986	P -062018-00001
1	1	BODY	R431007038	P -067247-00000
2*	1	O-RING, 7/32" x 11/32"	See Kit	See Kit
3*	1	O-RING, 3/8" x 1/2"	See Kit	See Kit
4	1	SPRING, Supply Valve	R431006176	P -063075-00000
5*	1	VALVE, Supply	See Kit	See Kit
6*	1	Gasket, Body	See Kit	See Kit
7	1	BODY, Valve Seat	R431007039	P -067248-00000
8	1	SPRING, Exhaust Valve	R431003030	P -052889-00000
9	1	SEAT, Exhaust Valve	R431005945	P -061986-00001
10*	1	O-RING, 1/8" x 1/4"	See Kit	See Kit
11*	1	DIAPHRAGM	See Kit	See Kit
12	1	SEAT, Spring	R431005946	P -061987-00000
13	1	HOUSING, Spring	R431005948	P -061992-00000
14*	1	O-RING, 1-1/8" O.D.	See Kit	See Kit
15	1	SPRING, Regulating 0-75 psi (0 - 5.2 bar)	R431005489	P -060360-00000
15A	1	SPRING, Regulating 0-140 psi (0 - 9.7 bar)	R431006081	P -062549-00000
16	1	SEAT, Ball & Spring	R431005947	P -061988-00000
17	1	BALL, 3/8" Dia.	R431001962	P -049680-00010
18	1	SCREW, Adjusting	R431005949	P -061993-00000
19	2	SCREW (Not shown)	R431001693	P -049109-00003
20*	5	O-RING, 3/8" O.D.	See Kit	See Kit

* Recommended spare parts to be retained in stock at all times.
 * Available in Repair Kit form, Part No. R431006319(P -063966-00000)

LOGIC TIMER UNIT



REF.	QTY.	DESCRIPTION	NEW PART NO.	OLD PART NO.
LOGIC TIMER UNIT, Complete (Time In)			R431006335	P -064003-00000
LOGIC TIMER UNIT, Complete (Time Out)			R431006336	P -064003-00001
1	1	LOGIC FLOW CONTROL VALVE (See parts list B6-105.03)	R431005931	P -061975-00002
2	1	VOLUME TIME IN for R431006335 (P -064003-00000)	R431006229	P -063395-00005
	1	VOLUME TIME OUT for R431006336 (P -064003-00001)	R431006230	P -063395-00006
3	2	"O" RING, 3/8" O.D.	R431006227	P -063395-00003
4	1	"O" RING, 1" O.D.	See Kit	See Kit
5	2	MOUNTING SCREW, No. 8-32 x 5½" LG	See Kit	See Kit
6	2	WASHER, 8-32	R431001775	P -049467-00016

Kit Part Number R431006224 (P -063393-00000)

NOTICE TO PRODUCT USERS

1. WARNING: FLUID MEDIA

AVENTICS pneumatic devices are designed and tested for use with filtered, clean, dry, chemical free air at pressures and temperatures within the specified limits of the device. For use with media other than air or for human life support systems, AVENTICS must be consulted. Hydraulic cylinders are designed for operation with filtered, clean, petroleum based hydraulic fluid; operation using fire-resistant or other special types of fluids may require special packing and seals. Consult the factory.

2. WARNING: MATERIAL COMPATIBILITY

Damage to product seals or other parts caused by the use of noncompatible lubricants, oil additives or synthetic lubricants in the air system compressor or line lubrication devices voids AVENTICS warranty and can result in product failure or other malfunction. See lubrication recommendations below.

AIR LINE LUBRICANTS! In service higher than 18 cycles per minute or with continuous flow of air through the device, an air line lubricator is recommended.* (Do not use line lubrication with vacuum products.) However, the lubricator must be maintained since the oil will wash out the grease, and lack of lubrication will greatly shorten the life expectancy. The oils used in the lubricator must be compatible with the elastomers in the device. The elastomers are normally BUNA-N, NEOPRENE, VITON, SILICONE and HYTREL. AVENTICS recommends the use of only petroleum based oils without synthetic additives, and with an aniline point between 180° F and 210° F.

COMPRESSOR LUBRICANTS! All compressors (with the exception of special "oil free" units) pass oil mist or vapor from the internal crankcase lubricating system through to the compressed air. Since even small amounts of non-compatible lubricants can cause severe seal deterioration (which could result in component and system failure) special care should be taken in selecting compatible compressor lubricants.

3. WARNING: INSTALLATION AND MOUNTING

The user of these devices must conform to all applicable electrical, mechanical, piping and other codes in the installation, operation or repair of these devices.

INSTALLATION ! Do not attempt to install, operate or repair these devices without proper training in the technique of working on pneumatic or hydraulic systems and devices, unless under trained supervision. Compressed air and hydraulic systems contain high levels of stored energy. Do not attempt to connect,

disconnect or repair these products when a system is under pressure. Always exhaust or drain the pressure from a system before performing any service work. Failure to do so can result in serious personal injury.

MOUNTING! Devices should be mounted and positioned in such a manner that they cannot be accidentally operated.

4. WARNING: APPLICATION AND USE OF PRODUCTS

The possibility does exist for any device or accessory to fail to operate properly through misuse, wear or malfunction. The user must consider these possibilities and should provide appropriate safe guards in the application or system design to prevent personal injury or property damage in the event of a malfunction.

5. WARNING: CONVERSION, MAINTENANCE AND REPAIR

When a device is disassembled for conversion to a different configuration, maintenance or repair, the device must be tested for leakage and proper operation after being reassembled and prior to installation.

MAINTENANCE AND REPAIR! Maintenance periods should be scheduled in accordance with frequency of use and working conditions. All AVENTICS products should provide a minimum of 1,000,000 cycles of maintenance free service when used and lubricated as recommended. However, these products should be visually inspected for defects and given an "in system" operating performance and leakage test once a year. Where devices require a major repair as a result of the one million cycles, one year, or routine inspection, the device must be disassembled, cleaned, inspected, parts replaced as required, rebuilt and tested for leakage and proper operation prior to installation. See individual catalogs for specific cycle life estimates.

6. PRODUCT CHANGES

Product changes including specifications, features, designs and availability are subject to change at any time without notice. For critical dimensions or specifications, contact factory.

*Many AVENTICS pneumatic valves and cylinders can operate with or without air line lubrication; see individual sales catalogs for details.

LIMITATIONS OF WARRANTIES & REMEDIES

AVENTICS warrants its products sold by it to be free from defects in material and workmanship to the following:

For twelve months after shipment AVENTICS will repair or replace (F.O.B. our works), at its option, any equipment which under normal conditions of use and service proves to be defective in material or workmanship at no charge to the purchaser. No charge will be made for labor with respect to defects covered by this Warranty, provided that the work is done by AVENTICS or any of its authorized service facilities. However, this Warranty does not cover expenses incurred in the removal and reinstallation of any product, nor any downtime incurred, whether or not proved defective.

All repairs and replacement parts provided under this Warranty policy will assume the identity, for warranty purposes, of the part replaced, and the warranty on such replacement parts will expire when the warranty on the original part would have expired. Claims must be submitted within thirty days of the failure or be subject to rejection.

This Warranty is not transferable beyond the first using purchaser. Specifically, excluded from this Warranty are failures caused by misuse, neglect, abuse, improper operation or filtration, extreme temperatures, or unauthorized service or parts. This Warranty also excludes the use of lubricants, fluids or air line additives that are not compatible with seals or diaphragms used in the products. This Warranty sets out the purchaser's exclusive remedies with respect to products covered by it, whether for negligence or otherwise. Neither, AVENTICS nor any of its affiliates will be liable for consequential or incidental damages or other losses or expenses incurred by reason of the use or sale of such products. Our liability (except as to title) arising out of the sale, use or operation of any product or parts, whether on warranty, contract or negligence (including claims for consequential or incidental damage) shall not in any event exceed the cost of replacing the defective products and, upon expiration of the warranted period as herein provided, all such liability is terminated. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHETHER FOR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE. No attempt to alter, amend or extend this Warranty shall be effective unless authorized in writing by an officer of AVENTICS Corporation.

AVENTICS reserves the right to discontinue manufacture of any product, or change product materials, design or specifications without notice.

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